

Digital Communications

How to get started guide

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Introduction

Welcome to the exciting realm of digital communications. Digital signals can sound like beeps, squeaks, musical notes, tones, pulses, noise, or any combination of these. With the proper equipment and software, you can encode (transmit) and decode (receive) these signals into readable and usable information using your computer. Depending on the mode, frequency and propagation, you could have worldwide communications running low power of about 20 watts or less. Once you get it running, digital can be a lot of fun, however, until you get your equipment functioning and the operation of the software figured out, it could also be very frustrating. The purpose of this document is to give you information on the basic equipment needed to get on the air using the digital modes on the MARS nets and reduce some of the start-up frustration.

Modes

There are many digital modes, including, but not limited to RTTY, PSK-31, Packet, Pactor, Amtor and MFSK. Currently, MT63 is the primary digital mode in the USAF MARS Southwest Area Region 9 using 1000 Hz bandwidth, Long interleave, centered on 1000 Hz (audio) with Olivia being the primary digital mode on the USAF MARS Transcon nets (multi-mode nets) using 32 tones, 1000 Hz bandwidth, centered on 1500 Hz (audio).

Because the digital modes in all MARS Regions or Service are not standardized, check with the Officials in your area to find out which modes and parameters are currently in use.

Software

A Terminal Node Controller (TNC) can be used, but isn't required for most of the digital modes. You can operate almost all of them with a computer and a sound card interface, which we will discuss below in more detail.

Multiple software programs are available to work with the computer sound card for digital communications and most of them are free. As with all computer programs, there is a learning curve and some of these are more difficult to use than others. You simply have to play with them to learn what they can do and how to make them do it.

More digital communication programs are available than listed here and if you are interested in the others, you can find them by doing a search on the Internet.

MixW	http://mixw.net
FLDIGI	http://www.w1hkj.com
Ham Scope	http://www.qsl.net/hamscope
MultiPSK	http://f6cte.free.fr/index_anglais.htm

If you're using MixW, go to the download page on their web site (URL shown above) and download the ModeOlivia3.zip file. Unzip it and place the ModeOlivia.dll file into the folder on your computer where the MixW files are located. The next time you start the MixW program, the Olivia mode will be available under the "Mode" drop-down menu. Follow the installation instructions available on the MixW web site for more detailed information.

Hardware

The most important piece of equipment is an "Isolation Interface" to connect your transceiver to the computer. This is an audio and keying interface with several different kinds available. You can build your own, or purchase a commercial unit that varies in price depending on the features. If you would like to build an interface, search the Internet and check the ARRL web site for the schematics. They are available from a variety of sources.

There are several commercially made isolation interfaces. One of them is the Buxcomm Rascal, which acts as a simple audio interface and keying circuit and is available from <http://www.buxcomm.com/catalog>. Others contain more circuitry and additional functions such as the Signalink <http://www.tigertronics.com> and the RigExpert <http://www.rigexpert.com>. You can find information on these interfaces or purchase them from their web sites.

It is recommended, but not necessary to use a second sound card in your computer for your digital communications to prevent the computer sounds from mixing with the digital audio while transmitting. This also allows the software to send an audio alert signal to the computer speakers. Most, if not all the digital communications software will work using the internal sound card that came with your computer. However, if you decide to use a second computer sound card, you can install it either internally, or externally. The RigBlaster is an interface that contains a sound card that is external from the computer and depending on the model, acts as a TNC, audio and keying interface. Check the RigBlaster web site <http://www.westmountainradio.com/content.php?page=RIGblaster> to make a purchase or for additional information.

If you're using the internal sound card that came with the computer, various publications recommended turning off the sound scheme to prevent broadcasting computer sounds.

As mentioned above, it is highly recommended you use an audio interface between your computer and transceiver to isolate them from each other, thereby reducing the chance of RF interference and eliminating voltages from either the computer, or the radio getting into each other through the audio and keying lines, which could cause computer lockup or damage. Almost all of the commercially available interfaces provide a circuit to key the transmitter. Some digital modes require this circuit because the audio levels are too weak to activate the VOX (Voice-Operated Keying) circuit and depending on the mode, the VOX is too slow for switching between transmit and receive.

Make sure to turn OFF both the computer and radio equipment before installing or connecting any hardware, unless directed otherwise when following the manufacturer's instructions. Using the audio isolation interface, connect the audio output from your computer, to the audio input of your transmitter, through the microphone jack or line-level audio input on the rear of the transmitter. Then connect the audio output (speaker) or line-level audio output on the rear of the receiver to the audio input of your computer through the microphone, or line in.

It is highly recommended, instead of using the radio microphone and speaker jacks, use the line-level connectors on the back of your transceiver if they are available. However, if you can only connect to the microphone and speaker jacks, it will still work, but you could have more difficulty adjusting the audio levels.

Setup

When you have installed the software and connected everything following the manufacturer's instructions, the next step is to set up the software to run correctly. This includes inputting your call sign, selecting the keying com port and adjusting the transmitted and received audio levels.

Turn your computer and radio equipment ON. Open (start) the software and find the setup menu. Depending on the program you use, this menu could be located in different places and if you have difficulty finding it, there are several people on the MARS nets, or HAM radio, using these different programs so at least one of them could assist you. Once you find the correct setup menu, input your MARS call sign (HAM call sign if you are using it on the HAM bands) and select an available com port on your computer for keying the radio. When you either select the com port, or click "OK" after selecting the com port, the program might tell you if it was unable to connect to that port. This depends on the program, as some do not and then it's by trial and error that you finally find the correct com port. If the software is unable to connect, keep trying a different com port until it does.

Most programs require your input on how to key the transmitter. The information with the software should tell you how to do this. If it doesn't, try each of the settings available until you find the one that works. The options are RTS (Request To Send) and DTR (Data Terminal Ready) on most programs. Some programs also offer CAT (Computer Aided Transceiver) as an option.

Once you have the software properly configured and it is keying and un-keying the transmitter, you have to adjust your input and output audio levels using the sound card software audio adjustment controls and depending on the model, the controls on the isolation interface. Make sure to follow the interface manufacturer's instructions. Some of the various programs have a menu item to open the audio adjustment controls, but if not, go to the sounds section of the computer operating system for these controls.

Adjust the sound card software audio controls to their lowest settings and then set the digital software to the mode you want to use. Adjust the audio from the receiver using the software adjustment for the Microphone or Line-in connectors on the computer sound card, depending on which you are using for the receive audio input

The waterfall background on the software should display at a subdued brightness or the digital signals could overload the software. Using the sound card software audio controls, adjust the audio level from the receiver going into the computer until the waterfall background starts to display and the signals will stand out. You might prefer a brighter background on the waterfall display, but don't make it too bright or the incoming signals will overload it.

If you can't get the audio adjustment low enough using the sound card software audio adjustment control, you can reduce it from the receiver, but that depends on how you are connected. If you are using the line-level output on the back of the radio and it's a late model that has a menu to control various settings, you might be able to reduce the output of the line-level audio from the rear jack to allow proper adjustment with the software control. "Line Level Audio" is independent of the speaker volume. This means it's a fixed level and doesn't change when you adjust the volume control. This is the preferred way to connect the receive audio. Consult your radio's instruction manual for additional information. If you connected through the receiver speaker, adjust the audio with the radio volume control as needed to allow proper adjustment of the sound card software controls. With the receive audio properly adjusted, you should be able to see signals on the waterfall (if there are any) and random characters could display in the receive text window from the receive noise. When a digital signal is properly tuned, decoded data should display in the received text window.

After the audio level from the receiver is properly adjusted, adjust the audio level going to the transmitter starting with the lowest settings on the sound card software adjustment. Before you begin to adjust the transmit audio from the computer, make sure your transmitter is connected to the correct antenna or dummy load and properly tuned. Also make sure the voice transmit audio (via the microphone) has been properly adjusted per your radio's instruction manual, or others will have difficulty decoding your digital signal. Set the transmitter to the lowest RF power output setting if adjustable. If you can adjust it, 20 watts or less will be fine and if you can't, it will still work.

One word of caution - Make sure you are watching the ALC (Automatic Level Control) meter while adjusting the transmit audio from the computer. Use the keying control in the software to switch the software and transmitter into transmit. Slowly increase the audio output from the computer using the software controls until the ALC meter just starts to indicate. Any more than that your transmit audio will be over driven causing splatter and interference. Many adjust the ALC level to just below this point and have had good results. When the transmit audio is adjusted, place the software back to receive which should also switch the radio back to receive. In addition, when making this adjustment and while operating in the digital mode, make sure your speech processor/compressor is

OFF. The transmit audio adjustment process is easy and shouldn't take more than a few seconds.

QuickMix is a program that is invaluable in saving your computer sound card settings so you can instantly return to them for specific applications. Although the web site says it's no longer supported and will probably be removed from the web site soon, as of this writing, it's still available at <http://www.ptpart.co.uk/product-withdrawn>. Once you have your sound card adjusted correctly, open QuickMix and save the sound card parameters giving them a name you will be able to remember. This way when you are ready to run digital, all you have to do is open your digital program and using QuickMix, load the file containing the sound card parameters, which instantly changes your sound card to the proper adjustment for digital communications using the parameters you previously set. Otherwise, you will have to adjust them every time, which is time consuming, and a real pain. Keep in mind if you are using or trying different digital software programs, due to their individual requirements, almost all of them will require different audio settings. With QuickMix, you can save each of their settings using names such as, MixW audio, FLDIGI audio, etc.

Tuning

Tuning the digital modes used to be a chore, as it required a tuning scope or meter. Now, with most of the software programs, depending on the mode, it could be as simple as clicking on the signal in the waterfall. First, make sure the mode is set to the one you want to use. As an example, if you have PSK-31 selected and you're on the 20 meter HAM band, set the frequency to 14.070 MHz. If the band is open, you will see several, or many thin lines on the waterfall and you will hear several different audio tones. Click on any of these lines and the transmission will be decoded and visible in the incoming text window. You are also ready to transmit on their frequency, or click on an empty space on the waterfall and call CQ. Other modes such as Olivia and MT63 require adjusting the tuning dial on the radio to move the signal to the mode lines on the waterfall.

Here is the explanation of Bandwidth and centering. When operating on MARS frequencies, we have to be exactly on the correct frequency. When you set the mode parameters as listed above for the Olivia and MT63 modes, you don't have to adjust the radio tuning dial, which if you did, would move you off frequency. When we set the Olivia mode to 1000 Hz bandwidth and center it on 1500 Hz, everyone is on the exact same frequency. 1000 Hz bandwidth means the audio signal is 1000 Hz wide. Centered on 1500 Hz means we are transmitting audio between 1000 Hz and 2000 Hz. In this case, we are using 1000 Hz as the lower audio frequency and 2000 Hz as the upper audio frequency. In MT63, using 1000 Hz bandwidth and centered on 1000 Hz. means we are using 500 Hz as the lower audio frequency and 1500 Hz as the upper audio frequency. This is the same as the Space (lower frequency) and Mark (upper frequency) in RTTY with the data transmitted between the two.

Operating

Operating on digital nets isn't much different from voice nets. However, the two major differences being the use of Z signals and Q signals, which we don't use on voice nets and everything is typed instead of spoken.

It is a good idea and highly recommended when transmitting, to start with two or three line feeds (carriage returns) before you type, or input your data to separate your transmission from the previous stations data, or from the random junk characters that sometimes show up in the received text window from receiver noise. It is also a good idea to end your transmission with two or three line feeds before switching from transmit to receive to separate your transmission from the next stations transmission or the random junk characters.

Almost every program used for digital communications has buffers, which is a place where you can input what is called "Canned Messages" so you don't have to type the same information every time. An example of a canned message on HAM radio could be something you send to every new contact: Your name, location and equipment, etc. You decide what you put into your buffers. On MARS, one of them could contain your check-in information for the net. You don't have to use them at all, but they do make life easier especially if you are a poor or slow typist.

Digital Nets

In the USAF MARS Southwest Area Region 9, the Multi-mode 9M1 net is Tuesday and Friday evenings (subject to change at any time) following the Region 9S1 net using voice and the MT63 mode. After opening the net, we sometimes switch to other modes for familiarization and equipment testing. Transcon is both voice and the Olivia digital mode from 1500 Z to 2100 Z on frequency TVE and from 0100 Z to 0300 Z on frequency TVD, Monday through Friday with days and time subject to change due to NCS/ANCS availability. Usually they can decode your digital transmission when they can't hear you on voice. This can make the difference in being able to check in and pass traffic.

Here are two other MARS digital activities in which you can participate. The WinLink2000 (WL2K) Radio Message Server (RMS) network and Automatic Link Establishment (ALE).

To use the RMS system, you will need a program such as Airmail and a TNC to use the Pactor mode, or a program such as RMS Express and WINMOR to use the computer sound card on the Packet mode. If you are using RMS Express and WINMOR, make sure you open the session with WINMOR WL2K selected in the drop down menu. Adjusting and using these programs are outside the scope of this document.

Airmail can be downloaded from <http://siriuscyber.net/airmail>

RMS Express can be downloaded from <http://www.winlink.org/ClientSoftware>

WINMOR can be downloaded from <http://www.winlink.org/WINMOR>

To operate ALE in the USAF MARS, you must first request an ALE identifier from your Area, or Region ALE Coordinator. In Region 9, the coordinator's billet call is AFF9LE. If you are in a different service or region, check with your Officials.

There are two different types of equipment available to operate ALE. One is a radio that has the ALE protocol and software built-in (hardware), which is expensive. The other is to use software and the computer sound card connected to your radio as described above. To download the MARS ALE software, you must first join the MARS ALE yahoo group found at <http://groups.yahoo.com/group/MARS-ALE>. Once you become a member of this group, you will have access to the software download section. If you are interested in running ALE on the HAM bands, go to <http://hflink.net> and look for the "ALE Software Download" link on the right to download the PCALE program.

The MARS ALE software will not work on the HAM bands and PCALE software will not work on MARS. Adjusting and using these programs are outside the scope of this document.

Operating Signals

Years ago Q and Z signals were developed to shorten transmissions by reducing specifically used words, phrases, questions and directions from many words to three letters, or three letters and one number, which shortens the time you are transmitting. Pro-signs used in digital communication are similar to those used on voice. The three you will use the most are DE, AR and K, which are defined below. Those of you who use CW probably already know many of the pro-signs, as they are the same.

A listing of Q signals, Z signals and pro-signs are available from a multitude of places, including several MARS publications such as the USAF MARS National Training Manual and the USAF MARS Radiotelegraph Operations Guide.

There are many operating signals and over time, you will remember those you use or see all the time. There is really no need to memorize them all, however it is a good idea to have them available on paper or the computer screen when checked into the digital nets.

Procedures vary depending on the area, region, service and net. In the Southwest Area Region 9, when the Multi-mode 9M1 net is opened, the NCS will send the Z signals ZKA and ZKB (defined below). Here is an example of the NCS opening the net.

9M1 DE AFA9JD ZKA ZKB AR

9M1	USAF MARS Southwest Area Region 9 Multi-mode net designator
DE	Pro-sign meaning "From" or "This is"
AFA9JD	MARS call sign
ZKA	"I am NCS."
ZKB	"Obtain permission before transmitting." Means the same as, This is a directed net.

AR Pro-sign for “End of transmission”. Means the same as Out on voice nets.

Here are two examples of checking into the net with and without traffic.

1. DE AFA9JD NEVADA ZKE ZBO 1R AFA9CM, 1R 9M1 K
2. DE AFA9JD NEVADA ZKE QRU K

In the first example (1), AFA9JD checked into the net giving his location and stating he had one routine message for AFA9CM and one routine message for everyone checked into net 9M1.

In the second example (2), AFA9JD checked into the net giving his location and stated he didn't have any traffic.

ZKE I (or ___) reports into the circuit (net)
ZBO I have traffic
QRU I have nothing for you
K Pro-sign for Over

Conclusion

It really isn't difficult getting set up or operating the digital modes and if you have any questions contact your Digital Manager. All MARS members in any service are invited to check into the Southwest Area Region 9, Multi-mode 9M1 net using voice or digital.

The HAM bands are a great place to get started using the digital modes. PSK-31 is an easy mode to operate using low power (20 watts or less) and a great way to learn your software. Depending on the time of day and propagation, you can find a lot of PSK-31 activity on 14.070 MHz. If you set up your software with your MARS call sign, don't forget to change it to your HAM call sign if you're going to operate on the HAM bands. In addition, it's very important to remember to change back to your MARS call when operating on the MARS frequencies.

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